Radio Science from NASA Commercial Lunar Payload Services Landers: ROLSES and LuSEE

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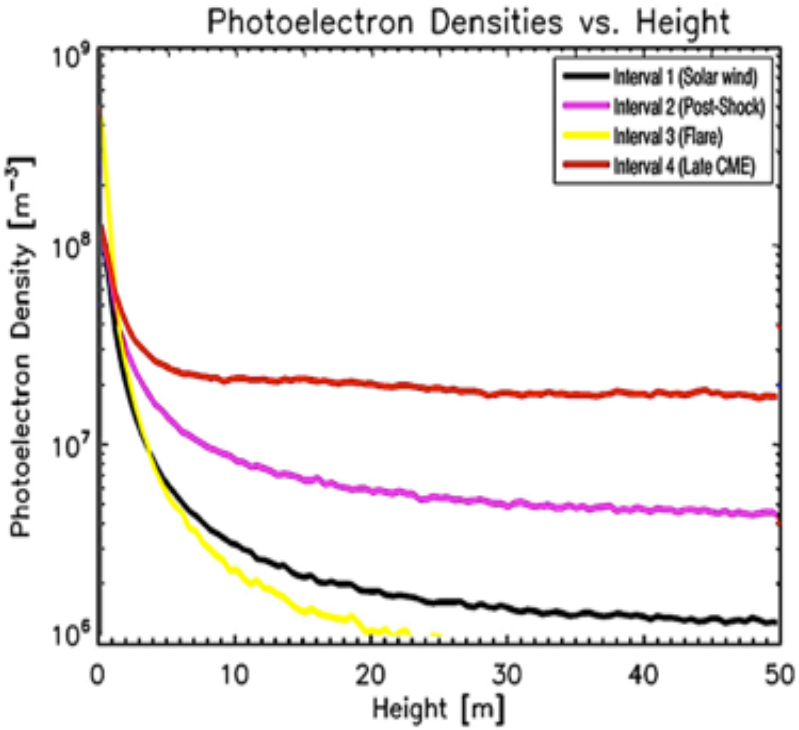
- The payload called ROLSES, meaning Radio Observations at the Lunar Surface of the photoElectron Sheath is being built by engineers at NASA/GSFC. It will go to the lunar surface in November 2021 on the NOVA-C lander of Intuitive Machines.

- The payload LuSEE, meaning Lunar Surface Electromagnetics Experiment, is a project of UC Berkeley, lead by Stuart Bale. It is basically a duplicate of the Parker Solar Probe FIELDS instrument suite, which is combination of about 6 different instruments.

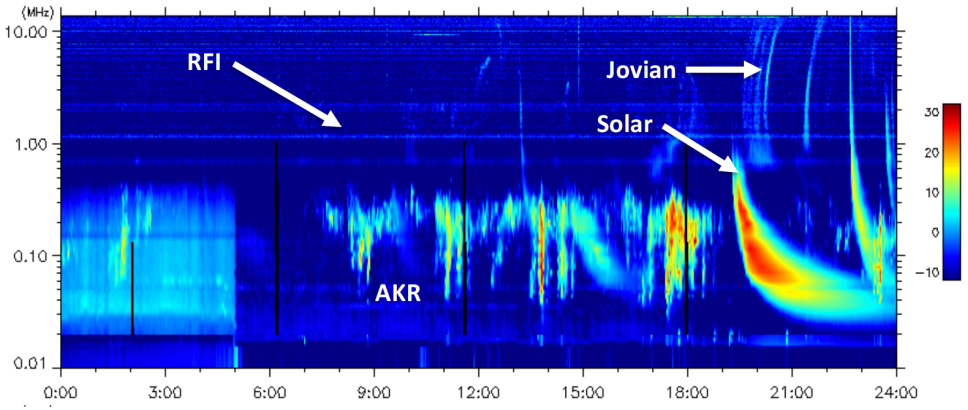
ROLSES Scientific Goals

1) determine the photoelectron sheath density values, varying over ~14 days. The figure below presented by Farrell et al. (2013) shows the variations of the photoelectron sheath as a function of height and variations based on different solar wind situations.
2) detect clouds of dust impacting the antenna or lander/rover. In comparison, spacecraft in the interplanetary environment or orbiting planets may be struck by dust particles, which releases electrons and ions from the surface, affects the surface photoelectron environment, and creates detectable electrical signals.



ROLSES Scientific Goals (continued)

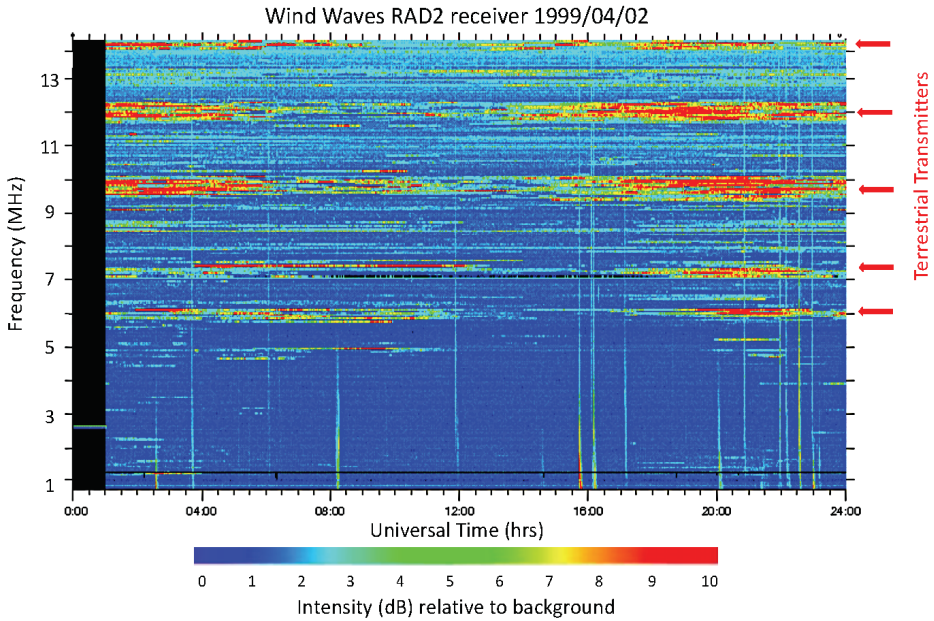
2) demonstrate detection of solar, planetary, and other radio emission from the lunar surface, similar to the Wind Waves dynamic spectrum shown



The WAVES instrument on the Wind spacecraft at Solar-Earth L1 shows solar radio bursts, Earth's auroral radio bursts (AKR), terrestrial ground-based transmitters (RFI), and Jovian radio emissions, during the 24 hr interval of 2/20/2012.

ROLSES Scientific Goals (continued)

4) Measure reflection of incoming radio emission from lunar surface and below. The reflections can provide information about the depth structure at the lander location.



5) A technology goal is to detect all radio frequency interference (RFI) from terrestrial transmitters for the ~14-day mission. The figure shows Wind/Waves data when Wind flew past the Moon in 1999. All the horizontal lines are terrestrial transmitters.

LuSEE instrument design

- Mag/boom
- E-Field Antennas (3)
- Low Noise Power Supply (LNPS)
- Magnetometer Electronics
- Radio Frequency Spectrometer (RFS)
- Data Control Board (DCB)
- Antenna Electronics Board (AEB)
- Digital Fields Board (DFB)
- Time Domain Sampler (TDS)
- Stuart has worked adding a Search Coil Magnetometer (SCM)
- And they are now working to do radio interferometry

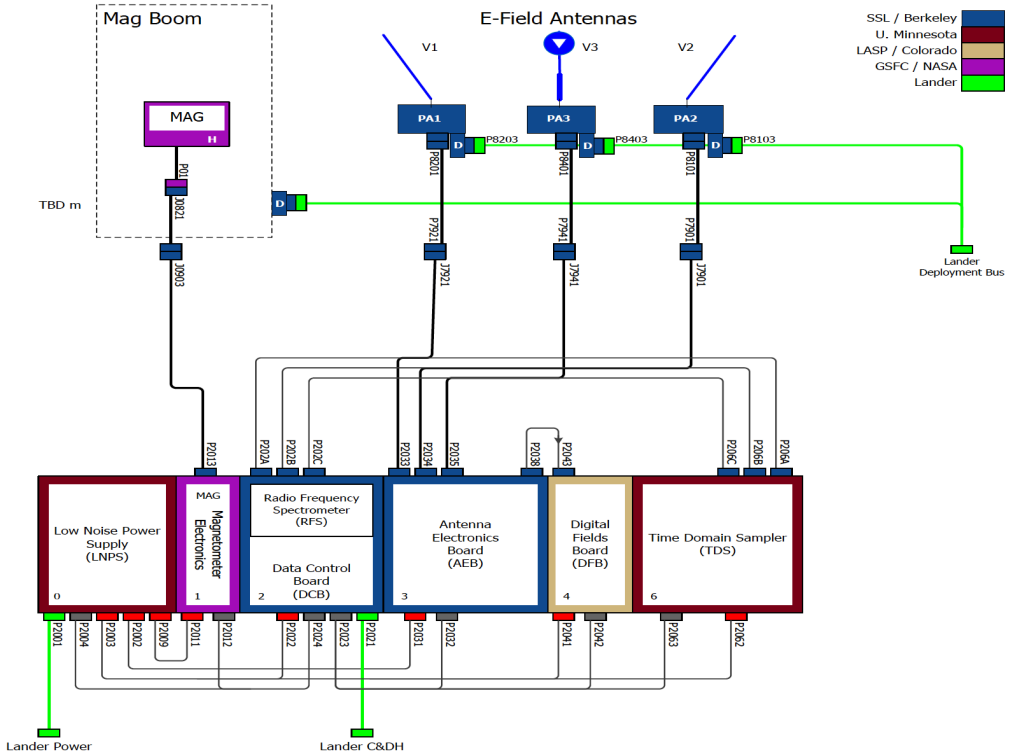


Figure D.5 LuSEE Block Diagram showing institutional responsibilities and electrical interfaces to the lander. The V1 and V2 antennas are STEREO/WAVES spares and V3 is the MAVEN flight spare.

LuSEE science objectives

- Heliophysical radio astronomy
- Astrophysical radio astronomy
- Lunar near-surface ionosphere
- Near-surface electric fields and photoelectron sheath
- Interplanetary/hypervelocity dust impacts
- Electrostatically mobilized dust grains
- Electromagnetic sounding of the lunar interior
- Plasma waves at the Moon

Summary

- ROLSES and LuSEE RFS are 2 radio frequency spectrometers going to the lunar surface.
- ROLSES has 4 Stacer antennas (2.5 m long)
- ROLSES frequencies are 2 bands (10 kHz - 3 MHz & 1 MHz - 30 MHz)
- LuSEE is a duplicate of the Parker Solar Probe FIELDS instrument suite
- LuSEE has 3 antennas (flight spares from STEREO/Waves and Maven)
- LuSEE RFS frequencies cover 10 kHz – 19.2 MHz (2 bands)
- ROLSES will go to the near side and LuSEE may go to Shrodinger crater